IT in Greenhouses

Contents: Reading and questions about the use of information technology to control the environment in greenhouses.

Time: 1 to 2 periods

Intended use: GCSE Science, Biology and Electronics

Aims:

- To complement and revise prior work on plant growth and nutrition
- To illustrate an important application of electronic control systems
- To show that the applications of science may call for an interdisciplinary approach
- To provide opportunities to practise skills in reading and comprehension.

Requirements: Students' worksheets No.906.

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The first two pages of this unit focus mainly on the biological aspects while the last two pages deal more with IT. It may be appropriate for students to study unit 905 *(The Impact of Information Technology)* first if the main emphasis is being given to the IT aspects of this unit.

Page 1 provides an opportunity for students to reflect on their knowledge and understanding of photosynthesis and the factors which control plant growth and development.

It helps to distinguish growth from development. This is important for growers. With lettuce the product is green leaves and only growth is concerned. With chrysanthemums and tomatoes the grower has to switch the crop from a vegetative to a reproductive phase to produce flowers in one case and fruit in the other. In commercial operations the grower has to consider economic factors. The optimum biological conditions may not give the most profitable outcome.

The unit is based on one of the leaflets about IT published by the Department of Trade and Industry. Sources of further information about IT are listed in the teachers' notes for unit 905.

Notes on some of the questions

Q.4 This sequencing activity is one of several methods of helping students to reflect on what they read. A discussion of these activities is included in the SATIS *General Guide for Teachers* (pages 35-9).

Figure 5 has been simplified in a number of ways. Carbon dioxide is not usually supplied from a cylinder. The commonest method of enrichment is to burn natural gas, LPG or paraffin in special burners in the greenhouse. The pure gas is more usually delivered from bulk liquid storage tanks than from cylinders.

The accepted method of monitoring carbon dioxide concentrations is to use a pump to extract gas samples from the greenhouse and pass them to an infra-red absorption analyser.

Q.7 (e) The human operator is needed in case of breakdown, power cuts, etc., to collect data as required, to input new data, to respond to alarm signals and so on.

(f) The central computer would need to be given new data, for example, when a new crop is to be grown, or if the growing parameters currently employed were found to be unsatisfactory.

(g) Disadvantages might include the initial cost of the system and the possibly serious and costly consequences of major breakdowns or power cuts.

Q.8 There have been automatic control systems in greenhouses since the 1930s. These systems have developed from simple on/off mechanisms through electro-mechanical and electronic systems to the present microprocessor networks. The advantage of IT is that several factors can be monitored and the interaction between them controlled to give optimum results in terms of environmental and economic performance.

Acknowledgement Photographs (Figures 2, 3, 4) by Peter Fiske, Head of Photography and Visual Aids, Glasshouse Crops Research Institute.

IT IN GREENHOUSES

The initials IT stand for information technology. Modern methods of collecting, storing and using information can help many people to do their work better. This unit describes the way in which IT can help market gardeners grow better crops more efficiently.

A controlled environment for plants

In a greenhouse, it is possible to control a plant's growing environment. Greenhouses can provide conditions which are close to the ideal for plants to grow as fast as possible.

Big market growers use greenhouses to produce crops such as tomatoes and cucumbers throughout the year. They need to get the conditions right for growth and development. It is particularly important to control the conditions shown in Figure 1.

Answer questions 1 to 3.

Questions

1 *Look at Figure 1. Four of the conditions listed can affect the rate at which plants lose water by transpiration. Which are the four?*

2 *Why is it likely that the conditions inside a greenhouse will change rapidly in the early morning and in the evening?*

3 *Why does burning natural gas (or paraffin) in a greenhouse provide extra carbon dioxide?*

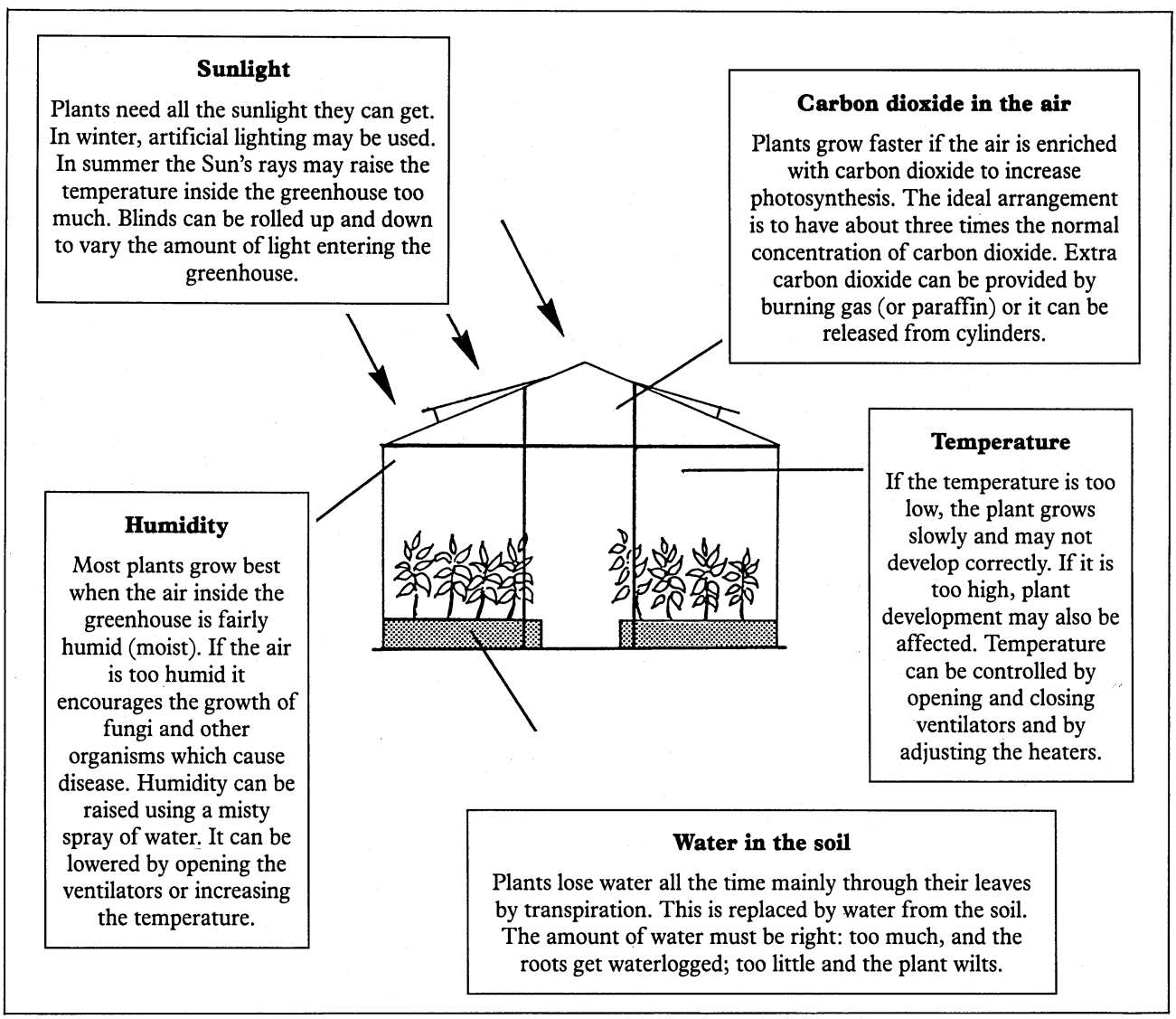

Figure 1 Controlling the conditions inside a greenhouse

How does information technology help?

In Figure 2 chrysanthemums are being grown in a greenhouse which is 20 metres wide. Flowers are picked for market throughout the year. This is possible because flowering is programmed by controlling the length of daylight and the temperature. Daylight is controlled with blackout screens. They are shown rolled back in the eaves in this picture. There is automatic ventilation equipment and an overhead irrigation system.

Figure 2 A large commercial greenhouse

Here are just a few of the control problems faced by a market grower in charge of a big greenhouse such as the one shown in Figure 2.

- The grower may have greenhouses spreading over tens of hectares. Controlling conditions in all of them is a big task.
- At certain times of day conditions change rapidly. This is likely to be the case at sunrise and at sunset. Checks and adjustments have to be made every few minutes to keep the growing environment constant.
- Heating a greenhouse in winter can be very expensive. Thousands of pounds can be saved by keeping the temperature just high enough, but not too high.
- Other factors have to be controlled as well as the conditions shown in Figure 1. These may include the amounts of minerals in the soil and the pH of the soil.

Figure 3 (left) shows some of the sensors which send information to the microprocessor which controls this greenhouse. The plants are lettuces

Figure 4 (right) shows tomatoes being grown in a solution of nutrients. The system is microprocessor controlled

How do the control systems work?

Let's take the carbon dioxide concentration as an example (see Figure 5). Here are the steps involved in an automatic adjustment to the amount of carbon dioxide in greenhouse air. The steps are **not** in the correct order.

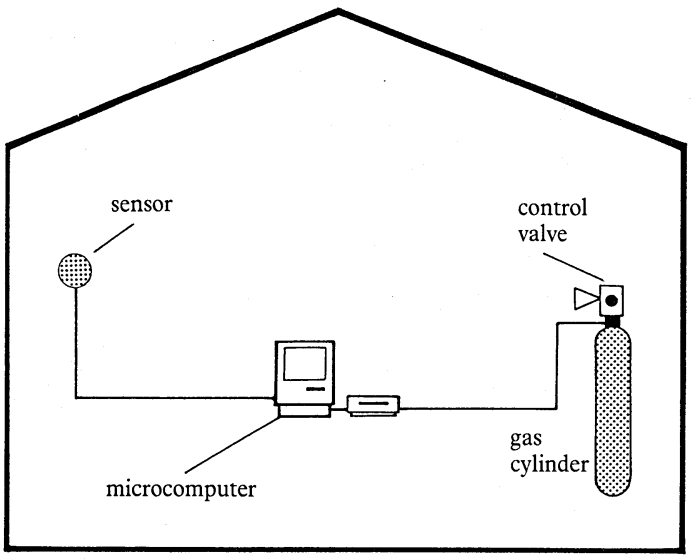

Figure 5 Carbon dioxide control by IT

- The signal opens the valve on the gas cylinder.
- The information is fed to a microcomputer.
- Gas is released until the sensor and computer detect that the carbon dioxide concentration in the air is in the correct range.
- The microcomputer compares the measurement with the required concentration which is stored in its memory.
- An infra-red sensor measures the concentration of carbon dioxide in the greenhouse air at regular intervals of time.
- If the carbon dioxide concentration is too low, the computer sends a signal to the control equipment on the gas cylinder.

Answer questions 4 to 6.

Questions

4 *Look at the steps involved in the automatic control of the carbon dioxide concentration listed (left) in the wrong order. Work out what you think is the correct order for these steps.*

5 *Now make a large copy of Figure 5. Write the steps involved in controlling the carbon dioxide concentration onto your diagram.*

6 *Now choose one of the other conditions shown in Figure 1. What sort of sensor could be used to detect changes in the condition and how could the sensor be connected to the computer? If the measurements show that the condition needs to be altered, how could this be done? Draw a diagram similar to Figure 5 to show the way in which your control system would work.*

Controlling several greenhouses

One microcomputer can control many different conditions at once. Each sensor is automatically checked every few seconds. A big market garden might have a central computer controlling several greenhouses.

The central computer is placed at a central station, as shown in Figure 6. It is connected to each of the outstations.

The central computer is connected to a weather station so that it can quickly respond to changing conditions. It also has a calendar clock and is programmed to make the necessary adjustments at sunrise and sunset.

The operator only has to visit the central station to see visual displays, or printouts, showing all the conditions in the various greenhouses.

Answer questions 7 and 8.

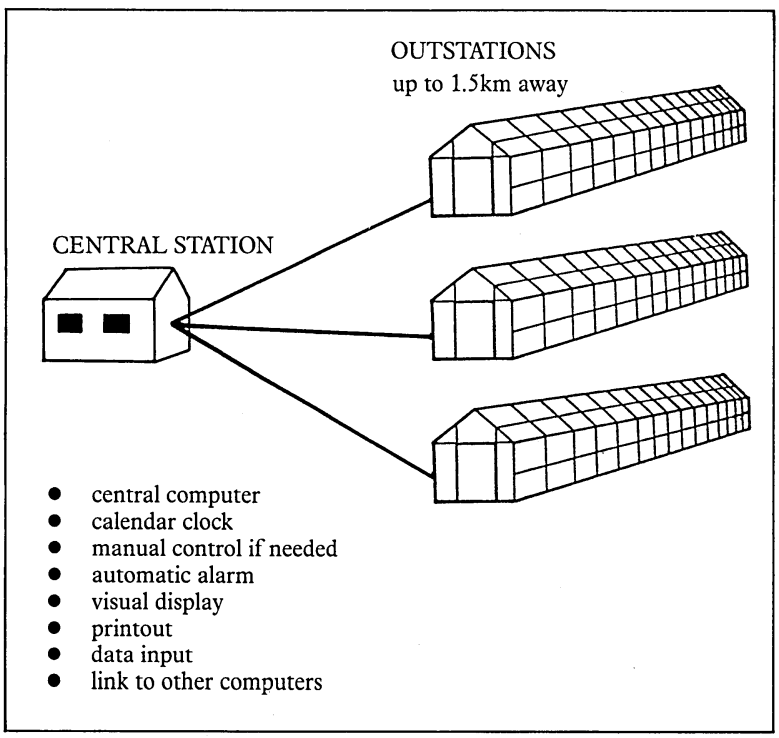

Figure 6 A central station controlling three outstations

Questions

7 *Look at Figure 6.*
(a) Why does the computer need to be connected to a clock?
(b) Why is the computer connected to a weather station?
(c) What is the purpose of having a visual display unit connected to the computer?
(d) What sort of alarm system is needed for a computer-operated greenhouse?
(e) The system is fully automatic but it needs human operators. Why?
(f) When might it be necessary for the market grower to give new data or programmes to the central computer?
(g) Make lists of what you think are the advantages and disadvantages of an automatic system of this type.

8 *Before the 1930s there were no automatic systems. People were employed to check and adjust the conditions. How would these workers have checked and adjusted:*
(a) temperature
(b) soil water?
Do you think this work was more or less skilled than operating the automatic system?